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Impact of *in situ* green manuring on performance of sugarcane in Bagalkote

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Abstract
The objective of this Front-Line Demonstration (FLD) on *in situ* green manuring in sugarcane was to reduce the soil salinity and to add N to the succeeding sugarcane crop and add maintaining soil fertility. The pooled results of Front-Line Demonstrations on *in situ* green manuring with Dhaincha (*Sesbania aculeate*) in sugarcane conducted over three years in different villages of Bagalkote revealed that, around 10 t/ha was additional yield realized by in situ green manuring with dhaincha with an additional income of Rs. 25000/ha. There was Slight increase in organic content (OC) of soil from 0.45% to 0.46%, reduction in soil pH from 8.16 to 7.99 and increase in soil N content from 186.40 to 190.50 kg/ac.

Keywords: *In situ* green manuring, dhaincha, suagacane

Introduction
The incorporation of plant materials to soils, with the objective of maintaining or improving fertility for subsequent crop, is known as green manuring. The inclusion of a legume fallow within a sugarcane cropping cycle is practiced to reduce populations of detrimental soil organisms [Pankhurst *et al*. 2005: Shoko and Zhou 2009) [10, 15], providing nitrogen (N) through biological fixation [Garside *et al*., 1996: Shoko and 2007) [3, 14] for weed suppression (McMahon *et al*. 1989: Cheruiyot *et al.* 2003) [8, 2]. Interest in the use of green manure's biomass has revived because of their role in improving soil quality and their beneficial N and non-N rotation effects (Jannink *et al.* 1996) [4]. Because of its nitrogen fixation potential, legumes represent an alternative for supplying nutrients, substituting or complementing mineral fertilization in cropping systems involving green manuring. This practice causes changes in soil physical, chemical and biological characteristics, bringing benefits to the subsequent crop both in small scale cropping systems and in larger commercial areas such as those grown with sugarcane (Ambrosano *et al*. 2005) [1]. The issue of reviving soils by bringing in the changes with respect to physical, chemical and biological characters is particularly important to Bagalkote district as this district is having more than 50% of its cultivable area under irrigation and more than one lakh ha under sugarcane with more than 34000 ha area under sugarcane has turnout saline soil.

Soil salinity restricts plant growth due to high salt content which leads to creation of osmotic stress in the root zone. The application of green biomass increases the release of salts into soil solution as result of mineral dissolution due to increase in partial pressure of carbon dioxide and organic acids which leads to leaching of salts below the root zone and creates favorable environment in the root zone of crop plants. The production of organic acids (amino acid, glycine, cysteine and humic acid) during mineralization of organic materials by heterotrophs and nitrification by autotrophs cause a decrease in soil pH. The applied green manures during decomposition produce CO_2, which dissolves in water to produce carbonic acid. This acid increases the solubility of calcium carbonate minerals by lowering the pH and dissolving the calcium carbonate and forming a host of complex calcium ion pairs, thus increasing soil solution Ca2+ concentration which replaces Na+ on exchange complex and thus cause reduction in exchangeable sodium percentage (ESP). Application of green manures also reduces concentration of certain cations and anions such as Cl-, SO42-, HCO3- and CO32- (Shirale *et al*. 2018) [13]. Taking cognizance of these facts a front-line demonstration was implemented in sugarcane growing areas where in the soils were claimed to be saline. This demonstration was conducted for three years in different villages of Bagalkote.

Material and Methods

Front Line Demonstration of *in situ* green manuring in Sugarcane was implemented by KVK Bagalkote. This technology recommended by UAS Dharwad and demonstration was carried out in Nainegali village Bagalkot (2018-19), Katarki village, Bilgi (2019-20 and 2020-21) for three years in 30 farmers' fields. Bagalkot and Bilagi talukas come under zone 3 of northern dry zone with 573 mm average annual rainfall. Dhaincha seeds were procured from Raita Sampark Kendra (RSK) and were sown at 18 inches spacing between line to line and maximum two irrigations were given till 45 days. Dhaincha seeds @25 kg/ac were sown before planting of sugarcane and mulching was done 45 days after sowing. After mulching sugarcane was planted in mulched fields. Farmers' practice without in situ green manuring with application of chemical fertilizers was kept as control plot, while *in situ* green manuring plot with Dhaincha incorporation 45 days after sowing in the main plot followed sugarcane planting was demo plot. Soil testing was conducted prior to *in situ* green manuring and after harvesting of sugarcane for ten parameters including pH, EC, OC, major and minor micronutrients. Yield and economics parameters were calculated after the harvest of sugarcane.

Results and Discussion

Table 1: Nutrient status of soils prior and after *in situ* green manuring in sugarcane (Nutrient status/ac)

	2018-19		2019-20		2020-21		Pooled data	
Parameter	**Pretest**	**Post test**	**Pretest**	**Post test**	**Pretest**	**Post test**	**Pretest**	**Post test**
pH	8.16	7.99	8.19	8.16	8.16	7.99	8.17	8.05
Ec (ds/m)	1.75	1.71	0.51	0.50	0.48	0.47	0.91	0.89
OC (%)	0.41	0.42	0.43	0.44	0.45	0.46	0.43	0.44
N (Kg/a)	160	162	184.2	185.10	186.40	190.50	176.87	179.20
P (Kg/a)	11	11	12.02	12.50	12.40	12.60	11.81	12.03
K(Kg/a)	61	62	81.9	82.01	83.90	84.10	75.60	76.04
Zn(ppm)	0.41	0.45	0.31	0.33	0.33	0.35	0.35	0.38
Fe (ppm)	2.08	2.07	2.25	2.28	2.29	2.31	2.21	2.22
Mn (ppm)	3.01	3.06	0.55	0.58	0.59	0.60	1.38	1.41
Cu(ppm)	0.16	0.18	0.69	0.70	0.72	0.73	0.52	0.54

Results of pooled data of three years presented in table 1 revealed that, there was slight reduction in pH (8.17 to 8.05) and Ec (0.91 to 0.89 ds/m), which indicates reduction in soil salinity, while slight increase was observed in the percent organic content of soil from 0.43 to 0.44. Slight increase in all the major and micro nutrients was also observed. This indicates that, there is improvement in soil nutrient status. The results are in line with the findings of studies conducted by other researchers. Intercropping and incorporation of legumes have established the beneficial effect of increasing the N use efficiency in cane (Shankaraiah *et al*., 1999) [12]. Similarly, Jayapaul *et al.* (2000) [5] stated. that the available plant nutrients like N, P, K and organic carbon content of the soil were in the increasing trend after the harvest of sugarcane when sunhemp was grown as intercrop and ploughed in situ on 45 days after sowing of intercrops. Ramesh (2001) [11] reported that soil available nitrogen was increased when incorporation of dhaincha green manure crop in between the rows of sugarcane.

Table 2: Yield and economic parameters of in situ green manuring in sugarcane

Parameters	**2018-19**		**2019-20**		**2020-21**		**Pooled data**	
	Demo	**Check**	**Demo**	**Check**	**Demo**	**Check**	**Demo**	**Check**
Yield (t/ha)	125	115	130	118	137	116	130.67	116.33
% increase	8%		10.16%		18.10%		12.09%	
COC (Rs./ha)	72000	81000	75000	83500	91000	87000	79333	83833
Gross Return (Rs./ha)	275000	253000	325000	295000	342500	290000	314167	279333
Net return (Rs./ha)	203000	172000	250000	211500	251500	203000	234833	195500
BCR	3.81	3.12	4.33	3.53	3.76	3.33	3.97	3.33

Pooled data on yield parameters over three years indicated that, there was 12.09 per cent increase in yield over check. About 130.67 t/ha yield was realized in demo plot while it was 116.33t/ha in check plot. Accordingly, there was an additional net profit of Rs. 39333 in the demo plot with B:C ratio of 3.97.

An investigation was conducted in Swaziland to assess the effects of fallowing and green manuring practices, over a seven-month period, on sugarcane yields and the physical properties of a poorly draining clay soil. In the subsequent first sugarcane crop after planting, yields were improved from 129 t ha^{-1} under continuous sugarcane to 141-144 t ha^{-1} after fallowing and green manuring, but there were no significant responses in the first and second ratoon crops (Nixon and Simmonds, 2004) [9]. Dhaincha incorporation through continuous line sowing registered significantly higher sugar yield (Kathiresan and Ayyamperumal, 1996) [6]. Mahendran *et al*. (1997) [7] indicated that intercropping of dhaincha recorded the maximum commercial cane sugar, followed by sunhemp intercropping over sole crop in both plant and ratoon canes.

Conclusion

To sustain the sugarcane production under intensive cultivation, the organic carbon content of the soil must be maintained by intercropping and incorporation of green manure crops. Growing of green manure crops in the inter row spacing and incorporation at appropriate time not only supplement the fertilizer nutrient requirements, but also

maintain the soil fertility and sustain the cane yield. Many findings confirmed that, there is an indication of saving of N up to 25%, when green manures were raised as intercrop in sugarcane. Intercropping and incorporation of leguminous crops have established the beneficial effect of improving the nitrogen use efficiency, cane yield besides improving the physic-chemical properties of soil. If the yield of sugarcane crop is to be maintained at high level on a long-term bases, it is necessary to evolve a system where by adequate supplies of organic manures through intercropping and incorporation of green manure crops and chemical fertilizers can be assured without damaging the soil structure and fertility status.

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